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Assessing the pedagogical readiness of preschool teachers in integrating Kumon methodologies within early childhood STEM frameworks

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Abstract

Integrating the Kumon method into preschool settings requires teaching competencies existing self-efficacy instruments do not capture. This study developed and validated a nine-dimensional preschool teacher self-efficacy scale for Kumon-oriented instruction, spanning child development knowledge, individual assessment, scaffolding, self-directed learning, mastery-based teaching, motivation, family partnership, literacy and mathematics content knowledge, and STEM integration, administered to 204 preschool teachers in southern Kazakhstan. Confirmatory factor analysis supported each subscale (CFI = .953-.999), with high internal consistency across all dimensions (α = .959-.981). Neither Kumon nor STEM teaching experience differentiated self-efficacy scores. Teaching experience showed a non-linear pattern, with mid-career teachers scoring lower than novice and senior teachers; education level had no predictive value. Latent profile analysis identified three distinct profiles, high (41.2%), moderate (40.7%), and low competency (18.1%), with mid-career teachers overrepresented in the low-competency class. STEM integration was consistently the weakest dimension, with implications for professional development in early childhood instruction..

Keywords: self-efficacy, Kumon method, preschool teachers, scale development, latent profile analysis, STEM integration

INTRODUCTION

Early childhood education is shaped by a fundamental tension between the need for structured, progressive teaching and the developmental variability of young children. This tension becomes more visible with the introduction of structured pedagogical frameworks such as the Kumon method into preschool settings. Originally developed for school-age children in mathematics and reading, the Kumon approach rests on self-directed learning, mastery-based progression, and small-step development (Kumon Institute of Education, 2019; Orcos et al., 2019). Adapting these principles to early childhood, where children's cognitive and emotional capacities are still developing, imposes responsibilities on teachers that go beyond traditional teaching competencies.

The quality of teaching in early childhood is largely tied to teachers' beliefs about what they can achieve. Bandura's (1997) social cognitive theory positions self-efficacy as a cognitive mechanism, not a personality trait, that mediates between professional knowledge and classroom behavior; teachers who doubt their own efficacy tend to avoid instructional challenges and show less persistence in the face of difficulty (Klassen & Tze, 2014; Zee & Koomen, 2016). Tschannen-Moran and Hoy (2001) showed that this construct is domain-specific rather than general, a distinction that matters most for teachers whose sense of professional efficacy is shaped by education rather than repeated teaching success (Perera & John, 2020; Wyatt, 2016).

The competencies required for Kumon-oriented preschool teaching are multidimensional and theoretically distinct from the domains covered by

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Contribution to the literature

- This study introduces the first psychometrically validated instrument specifically designed to measure preschool teachers' self-efficacy for Kumon-oriented instruction, integrating nine competency domains that existing general, STEM-specific, or early-childhood scales address only separately.
- It applies a Bayesian analytical framework to teacher self-efficacy research, providing direct evidence for equivalence between groups rather than merely failing to reject a null hypothesis. Using latent profile analysis (LPA), it further shows that teacher competence in this context is organized into qualitatively distinct profiles rather than a single continuous distribution.
- STEM integration competency (STEMIC) emerged as a consistently weak domain across all analyses, identifying a specific target for professional development in structured early childhood instructional systems.

existing self-efficacy tools. Effective implementation requires knowledge of child development (Piaget, 1952; Vygotsky, 1978), diagnostic assessment and monitoring skills (van de Pol et al., 2010; Wood et al., 1976), the ability to facilitate self-directed learning (Zimmerman, 2002), and mastery-based teaching expertise (Bloom, 1968; Guskey, 2007). It further requires motivational and emotional support grounded in self-determination theory (Deci & Ryan, 2000), family partnership competencies consistent with the home-based structure of the Kumon system (Bronfenbrenner, 1979; Epstein et al., 2018), content knowledge in early literacy and mathematics (Ball et al., 2008; Clements & Sarama, 2021), and STEM integration competencies that remain unevenly developed among early childhood educators (Wan et al., 2021; Yang et al., 2023). These nine domains do not operate independently, but in interrelationships that determine whether a teacher can put Kumon's principles into developmentally appropriate practice.

Despite growing interest in the Kumon method and STEM-oriented early childhood education, no instrument measures the specific pattern of self-efficacy Kumon-aligned preschool teaching requires. General teacher self-efficacy scales (Tschannen-Moran & Hoy, 2001) capture overall teaching confidence but not the pedagogical requirements of personalized, mastery-based systems; STEM self-efficacy measures focus on domain-specific content while overlooking the relational, diagnostic, and family-partnership competencies Kumon practice depends on (Sukri & Mahmud, 2022; Yang et al., 2023); and existing early childhood competency scales, though multidimensional, are not designed around Kumon's specific pedagogical structure (Höltge et al., 2019; Lawrence et al., 2020; Perren et al., 2017). This gap makes it difficult to determine which competency areas teachers struggle with most, how experiential and demographic variables shape self-efficacy across these areas, or whether qualitatively different competency profiles exist within the teacher population.

This study was designed to address that gap. A nine-dimensional self-efficacy scale, integrating teacher self-efficacy theory with research on child development, scaffolding, self-regulated learning, mastery-based instruction, motivation, family partnership, content knowledge, and STEM integration, was developed and administered to 204 preschool teachers in southern Kazakhstan, guided by the following research questions:

1. What are preschool teachers' self-efficacy levels across the nine Kumon-oriented competency dimensions?
2. Does previous experience with the Kumon system make a difference in self-efficacy perceptions along the competency dimensions?
3. Does prior STEM teaching experience make a difference in self-efficacy perceptions along the competency dimensions?
4. Does self-efficacy differ across competence dimensions according to the level of teaching experience?
5. Does self-efficacy differ across efficacy dimensions according to educational level?
6. Are there distinguishable latent self-efficacy profiles among preschool teachers, and if so, how are demographic and experiential variables distributed within these profiles?

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The Kumon Method and Teacher Self-Efficacy

The Kumon method is an individualized learning system developed by Toru Kumon in the 1950s, based on four principles: individual pacing, self-directed learning, mastery-based development, and small-step progression (Orcos et al., 2019). Each student begins at a level he or she can complete independently and advances only after demonstrating consistent mastery (Kumon Institute of Education, 2019). Although originally designed for school-age children, the method has since been adapted to preschool contexts, where it overlaps with developmental theories of readiness and individual differences (Orcos et al., 2019). In this system, the teacher functions less as a direct source of information than as a diagnostic facilitator, responsible for assessing each child's proficiency, tracking daily progress, and sustaining intrinsic motivation (Kumon Institute of Education, 2019). Kunter et al. (2013) and Fauth et al. (2019) have shown that teachers' professional effectiveness, expressed through knowledge and motivation, is an important determinant of teaching quality; the specialized demands of Kumon-oriented teaching accordingly call for a dedicated assessment of teacher competence.

The scale developed in this study is grounded in Bandura's (1997) social cognitive theory, which defines self-efficacy as an individual's belief in his or her capacity to execute the actions required to achieve a given outcome. Tschannen-Moran and Hoy (2001) extended this framework by arguing that teacher self-efficacy is domain-specific rather than general: a teacher confident in classroom management may not feel equally confident guiding mathematical reasoning or self-directed learning. Empirical findings support this domain specificity. Perren et al. (2017), studying 506 Swiss educators, found that domain-specific knowledge predicted child-centered behavior more strongly than length of training, while Höltge et al. (2019) identified a three-factor model distinguishing language, social-emotional, and mathematics teaching among 368 German preschool teachers. Lawrence et al. (2020), in a validation study of over 3,000 head start educators, found that less experienced teachers sometimes reported stronger self-efficacy, suggesting that early-career optimism can coexist with competency deficits. Zou (2022) added a further nuance: although developmental appropriateness beliefs and classroom practices were moderately related (r = .557), the gap between the two indicated that models of efficacy should account for mediating processes such as self-regulation. Taken together, these findings support the measurement of self-efficacy across multiple, theoretically distinct dimensions rather than as a single global construct.

Core Pedagogical Competencies: Child Development, Scaffolding, and Mastery-Based Instruction

Effective preschool teaching depends on a working understanding of child development. Piaget's (1952) account of preoperational thinking and Vygotsky's (1978) zone of proximal development, the gap between what a child can do independently and what he or she can achieve with guidance, together inform how a Kumon educator sequences material and identifies each child's starting point. Preschool teachers are expected to recognize and respond to differences across cognitive, social-emotional, and kinesthetic domains, a competency NAEYC (2020) treats as central to effective teaching. Alasmri et al. (2026) found that Saudi preschool mathematics teachers scored lower on assessment methods (mean [M] = 3.27) than on planning (M = 3.54) or teaching (M = 3.50), suggesting that diagnostic assessment is a particularly demanding competency area.

Three interrelated theoretical traditions describe how Kumon teachers support learning. Scaffolding, as conceptualized by Wood et al. (1976) and elaborated by van de Pol et al. (2010, 2019), involves situation-adapted support that is gradually withdrawn as the learner assumes responsibility; the Kumon teacher enacts this through placement testing, incrementally difficult worksheets, and daily independent practice. Zimmerman's (2002) model of self-regulated learning, supported by Panadero's (2017) meta-analytic findings on autonomy and goal-setting, describes the cyclical process, anticipation, performance, and reflection, through which young children gradually learn to direct their own work. Finally, Bloom's (1968, 1984) mastery-based learning paradigm, in which students given sufficient time and individualized feedback can reach levels roughly two standard deviations (SDs) above traditional instruction, together with Carroll's (1963) reframing of individual differences as differences in learning speed, provides the clearest theoretical anchor for Kumon's progression system. Guskey (2007, 2023) has shown that such mastery-based interventions are most effective when teachers are specifically prepared to deliver them.

Relational and Content Competencies: Motivation, Family Collaboration, and Early Content Knowledge

Self-determination theory (Deci & Ryan, 2000) holds that sustained motivation depends on meeting learners' needs for competence, autonomy, and belonging, needs that are difficult to sustain in a repetitive, worksheet-based system unless the teacher actively supports them (Niemiec & Ryan, 2009). Ye et al. (2024), studying 580 Chinese preschool teachers, found that self-efficacy partially mediated the relationship between emotional competence and performance, with teaching experience moderating only the input side of this pathway. Kaplan Toren and Schwartz (2025) reported that a professional development intervention with 59 Israeli assistant teachers raised self-efficacy for working with diverse children (M_{pre} = 3.23, M_{post} = 3.52) and for communicating with parents (M_{pre} = 3.48, M_{post} = 4.00), without a comparable change in overall self-efficacy, indicating that relational competencies are more responsive to targeted training than global confidence is.

Family involvement is similarly central to the Kumon model, in which daily homework monitored by parents is a mandatory rather than optional component. Epstein et al.'s (2018) framework of school-family-community collaboration and meta-analytic evidence linking parental involvement to academic and social-emotional outcomes (Hill & Tyson, 2009; Jeynes, 2012) provide the theoretical basis for this dimension. Moen and Sheridan (2020) validated a family-partnership self-efficacy scale with 255 head start educators and found that neither education level nor teaching experience predicted scores. Kirkic and Cetinkaya (2020) similarly found family involvement to be the lowest-scoring self-efficacy dimension among 264 Istanbul preschool teachers, underscoring that this competency cannot be assumed to develop automatically with experience.

Content knowledge is a further requirement, since Kumon's preschool curriculum centers on early literacy and mathematics. Shulman's (1987) distinction between content knowledge, pedagogical content knowledge, and general pedagogical knowledge, extended to mathematics by Ball et al. (2008), together with evidence on the predictors of early reading (Lonigan & Shanahan, 2009) and number sense (Clements & Sarama, 2021), frame content knowledge as a distinct competency rather than a background assumption. Höltge et al.'s (2019) three-factor model, distinguishing language, social-emotional, and mathematics teaching, and Orcos et al.'s (2019) large-sample study of the Kumon mathematics method in Spain (N = 30,849 students) both indicate that content-area confidence does not transfer uniformly across domains.

STEM Integration and the Role of Experience and Education

STEM integration is the final and, as this study's findings later confirm, most consistently underdeveloped competency. Early childhood settings offer favorable conditions for scientific reasoning and engineering thinking given young children's natural curiosity (English, 2016; McClure et al., 2017), and Wan et al.'s (2021) systematic review links STEM activity quality directly to educator competence and attitudes. Measurement in this area remains underdeveloped, however. Yang et al. (2023) validated a STEM teaching self-efficacy scale with 418 Chinese teachers, finding scores related to employment status and age but not to gender or teaching experience. Sukri and Mahmud (2022), studying 72 Malaysian kindergarten teachers, found a strong link between efficacy and STEM practice (r = .76) but no predictive role for academic background or experience. Hsin et al. (2023), with 384 Taiwanese teachers, found self-efficacy to be the only positive predictor of science teaching practice, with mastery experience and social support jointly explaining 70% of the variance in self-efficacy itself. This pattern, replicated across cultural contexts, suggests that general teaching confidence transfers only partially to STEM-specific, inquiry-based practice.

The broader relationship between experience, education, and self-efficacy is similarly counterintuitive. Infurna et al. (2018) found that experience gained outside the birth-to-second-grade range negatively predicted preschool self-efficacy, while Lawrence et al. (2020) found that less experienced head start teachers sometimes reported higher self-efficacy than their more experienced colleagues. Education level shows a parallel pattern of non-significance across studies, whether for family-partnership self-efficacy (Moen & Sheridan, 2020) or for STEM self-efficacy (Sukri & Mahmud, 2022; Yang et al., 2023), suggesting that formal credentials capture exposure to training but not the self-regulatory and belief-based components that self-efficacy scales are designed to measure.

Person-Centered Approaches and Synthesis

Most research on teacher self-efficacy relies on variable-centered designs that compare group means and assume continuous, normally distributed differences. LPA offers a different lens, asking not how groups differ on average but whether qualitatively distinct subgroups exist within the population (Spurk et al., 2020). This distinction matters theoretically. The non-linear experience effects reported by Infurna et al. (2018), the domain-specific null findings on education level reported by Moen and Sheridan (2020), and the moderated mediation pattern reported by Ye et al. (2024) all suggest that the relationship between teacher characteristics and competence is more layered than mean comparisons alone can reveal. This is why the present study complements its variable-centered analyses with a person-centered one.

Across these literatures, the Kumon-based preschool teacher emerges as a practitioner who must integrate child development knowledge, specialized instructional strategies, emotional sensitivity, and family collaboration within a single, mastery-based, self-directed pedagogical model. The nine competency domains operationalized in this study, child development knowledge, individual assessment, scaffolding, self-directed learning support, mastery-based instruction, motivation and emotional support, family collaboration, early content knowledge, and STEM integration, together provide the theoretical foundation for the scale developed below.

MATERIALS AND METHODS

Research Design

The present study was designed within a quantitative framework and adopted a cross-sectional survey approach to develop and evaluate a self-efficacy scale for measuring preschool teachers' competency perceptions in Kumon-oriented early childhood instruction. Scale development research of this kind is grounded in the premise that a theoretically coherent item structure, supported by expert evaluation and psychometric evidence, produces instruments capable of yielding meaningful and interpretable scores within the target professional population (Bandura, 1997; Tschannen-Moran & Hoy, 2001). Because the study was concerned with teachers' subjective perceptions of their own capability rather than with directly observed classroom behavior or child outcome measures, self-report survey methodology was the most appropriate choice for the research questions at hand.

Participants

The study was conducted in a city located in the southern Kazakhstan. The target population consisted of preschool teachers employed in early childhood education institutions within that city. Data were collected in February-March 2026 through a structured online survey distributed via a shared link. Participation was entirely voluntary, and respondents were informed of the study's purpose and the anonymity of their responses before proceeding to the items. No incentives were provided for participation.

Of the 248 teachers who initially accessed the survey, 204 were retained in the final dataset following data screening. Cases with substantial item-level omissions and those displaying invariant response patterns, in which identical values were selected across all items regardless of content, were excluded from the analyses. The retained sample of 204 participants served as the basis for all subsequent analyses.

In terms of educational background, 95 participants (46.6%) held a college diploma, 90 (44.1%) held a bachelor's degree, and 19 (9.3%) held a postgraduate qualification. Regarding teaching experience, participants were classified into three groups based on years of service: novice teachers with 1 to 5 years of experience (n = 104, 51.0%), mid-career teachers with 6 to 15 years (n = 64, 31.4%), and senior teachers with 16 or more years (n = 36, 17.6%). With respect to familiarity with the Kumon system, 84 participants (41.2%) reported prior experience with it, while 120 (58.8%) did not. About STEM teaching experience, 122 participants (59.8%) indicated that they had engaged in STEM-related instructional activities, compared to 82 (40.2%) who had not.

Instrument Development

Theoretical basis and item generation

The item pool for the scale was constructed through a systematic engagement with the theoretical framework presented before. Nine competency domains relevant to Kumon-aligned preschool instruction were identified from that review and used to organize the item generation process: knowledge of child development and individual differences (KCDID), individual assessment and monitoring competency (IAMC), scaffolding and guidance skills (SGS), supporting self-directed learning competency (SSDLC), motivation and emotional support competency (MESC), family communication and collaboration competency (FCCC), early literacy and early mathematics knowledge (ELEMN), mastery-based instruction and small-step progression (MBISSP), and STEMIC.

The items were constructed as self-efficacy belief statements, articulated in the first person and grounded in particular pedagogical behaviors rather than broad professional attitudes. This method follows Bandura's (1997) advice that domain-specific self-efficacy measurement should pay close attention to the specific tasks that need to be done in the context being measured, and Tschannen-Moran and Hoy's (2001) advice that teacher self-efficacy items should show clear instructional actions.

A five-point Likert-type answer scale was employed, with options from 1 (strongly disagree) to 5 (strongly agree), a format commonly utilized in similar teacher competency and self-efficacy assessments (Kirkic & Çetinkaya, 2020; Yang et al., 2023).

Expert review and item revision

Following the initial item draft, the scale was presented to a five-member expert review board to assess content appropriateness and item quality. The panel consisted of three researchers actively specializing in early childhood education, one researcher with documented expertise in the Kumon method, and one researcher whose work focuses on STEM integration in early childhood settings. Each expert reviewed all items. In addition, they stated that they examined the items related to their area of expertise in more detail.

Expert feedback was provided in written form. Reviewers assessed each item for clarity, precision of wording, and representational fidelity to the intended competency dimension. The feedback received was predominantly concerned with item phrasing: in several instances, reviewers recommended specific lexical adjustments to ensure that statements more precisely described observable, context-bound pedagogical behaviors rather than general professional attitudes. All proposed revisions were evaluated by the researcher and incorporated where they improved the specificity or clarity of an item without altering its intended competency focus. No items were removed during this stage.

Formal content validity ratio (CVR) or content validity index (CVI) calculations were not conducted as part of this process; the expert review was limited to a qualitative round of feedback on item wording and theoretical alignment. This is acknowledged as a methodological limitation of the scale development process, rather than a deliberate design choice, since a quantitative CVI would have provided stronger evidence for the representativeness of the item pool relative to the nine theoretical dimensions. This limitation is revisited in the limitations section.

Table 1. CFA fit indices by subscale

Dimension	Items	χ^2	df	p	CFI	TLI	SRMR	RMSEA	90% confidence interval
KCDID	7	103.0	14	<.001	.953	.930	.023	.176	[.145, .209]
IAMC	7	69.2	14	<.001	.976	.964	.011	.139	[.107, .173]
SGS	7	71.2	14	<.001	.969	.954	.021	.142	[.110, .175]
SSDLC	6	37.9	9	<.001	.985	.975	.009	.125	[.086, .168]
MESC	6	8.8	8	.357	.999	.999	.006	.023	[.000, .087]
FCCC	6	87.6	9	<.001	.961	.935	.014	.207	[.169, .247]
ELEMN	6	53.7	9	<.001	.972	.953	.017	.156	[.117, .198]
MBISSP	6	33.1	9	<.001	.987	.979	.009	.115	[.074, .158]
STEMIC	7	107.0	14	<.001	.959	.938	.017	.181	[.150, .213]

Note. MESC model includes one freed residual covariance (I28-I29) & RMSEA values should be interpreted with caution due to the low degrees of freedom in single-factor models with few indicators (Kenny et al., 2015)

Final scale structure

Following expert review and item revision, the finalized instrument comprised 58 items distributed across the nine competency dimensions (**Appendix A**). The item distribution was as follows: KCDID (items I01 to I07, seven items), IAMC (items I08 to I14, seven items), SGS (items I15 to I21, seven items), SSDLC (items I22 to I27, six items), MESC (items I28 to I33, six items), FCCC (items I34 to I39, six items), ELEMN (items I40 to I45, six items), MBISSP (items I46 to I51, six items), and STEMIC (items I52 to I58, seven items). The five-point Likert-type response format was retained in its original form.

Construct validity: Confirmatory factor analysis

To assess the factorial validity of the proposed nine-dimensional structure, confirmatory factor analysis (CFA) was conducted separately for each subscale using the Jamovi program (The Jamovi Project, 2024). Since each dimension was theoretically derived as an independent competency domain and the item-participant ratio was not suitable to construct a full nine-factor model, a within-dimension approach was adopted with 204 participants for 58 items. Accordingly, a single-factor congeneric model was defined for each subscale, and model fit was assessed using the comparative fit index (CFI), Tucker-Lewis index (TLI), standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA).

Table 1 presents the fit indices for all nine subscales. CFI values ranged from .953 (KCDID) to .999 (MESC) and TLI values ranged from .930 (KCDID) to .999 (MESC). Thus, it was observed that all dimensions met or were very close to the traditional threshold values of .95 for CFI and .90 for TLI (Hu & Bentler, 1999). SRMR values were low in all dimensions (between .006 and .023) and showed that the difference between the observed correlation matrix and the correlation matrix implied by the model was quite limited. On the other hand, RMSEA values were relatively high in some dimensions and ranged from .023 (MESC) to .207 (FCCC). This is consistent with the fact that RMSEA tends to produce high values in models with low degrees of freedom and few indicators per factor (Kenny et al., 2015). Since each subscale consists of only six or seven items and the models have 9 or 14 degrees of freedom, high RMSEA values should be interpreted cautiously and in combination with other fit indices rather than as evidence of poor fit alone.

All standardized factor loadings were statistically significant ($p < .001$). Loadings ranged from .888 (I45, ELEMN) to .947 (I10, IAMC) and were significant for content. No item yielded a factor loading below the commonly used lower limit of .50. This finding indicates that each item contributed significantly to the latent dimension to which it belonged. An earlier reporting of this analysis listed the standardized loading for I10 as 1.30, a value above the theoretical upper bound of a standardized loading and therefore a signal of a possible Heywood case or improper solution. Following this observation, the IAMC subscale was re-estimated with maximum likelihood estimation and the item-level covariance structure was inspected in detail. The re-estimation reproduced the global fit indices reported in **Table 1** exactly (χ^2 = 69.2, df = 14, CFI = .976, TLI = .964, RMSEA = .139) and yielded a standardized loading of .947 for I10, with a positive and interpretable residual variance (.103). No negative residual variances or out-of-bounds loadings were present in the corrected solution for any of the seven IAMC items. The originally reported value of 1.30 is therefore attributed to a reporting or transcription error rather than a genuine improper solution, and the corrected value is reported here. In the MESC dimension, the error covariance between items I28 and I29 was released based on the modification index findings and theoretical justification. After this adjustment, the model was found to provide a near-perfect fit (CFI = .999, RMSEA = .023, SRMR = .006).

As a complementary investigation, exploratory factor analysis was conducted on all 58 items to test whether the entire set of items could be adequately explained under a single general factor. The one-factor solution explained only 40.2% of the total variance. This finding provides empirical support for the multidimensional nature of the instrument and confirms that the nine competency domains cannot be combined under a single construct.

Table 2. Internal consistency reliability estimates for scale dimensions

Dimension	Items	α	ω
KCDID	I01-I07	0.971	0.971
IAMC	I08-I14	0.981	0.982
SGS	I15-I21	0.970	0.970
SSDLC	I22-I27	0.980	0.980
MESC	I28-I33	0.963	0.963
FCCC	I34-I39	0.980	0.981
ELEMN	I40-I45	0.959	0.962
MBISSP	I46-I51	0.979	0.979
STEMIC	I52-I58	0.980	0.980

Reliability

Internal consistency reliability was estimated separately for each of the nine dimensions using both Cronbach's alpha (*a*) and McDonald's omega (ω). As presented in **Table 2**, all nine dimensions demonstrated exceptionally high internal consistency. *a* values ranged from 0.959 (ELEMN) to 0.981 (IAMC and FCCC), and McDonald's omega values ranged from 0.962 (ELEMN) to 0.982 (IAMC). The near-perfect correspondence between alpha and omega across all dimensions indicates that items within each subscale are effectively tau-equivalent, and that the reliability estimates are robust to the choice of coefficient. All values substantially exceed the threshold of 0.90 considered indicative of excellent reliability for high-stakes measurement purposes (Nunnally & Bernstein, 1994; Taber, 2018). Taken together, these findings provide strong psychometric evidence that each dimension functions as an internally coherent and reliable measurement unit. Given the uniformly high alpha and omega values across all nine dimensions, item-level correlations were inspected directly rather than relying on the reliability coefficients alone. Inter-item correlations within each subscale were uniformly high, with dimension-level means ranging from r = .80 (ELEMN) to r = .89 (IAMC and FCCC), and few item pairs fell below r = .70. This pattern suggests that the near-perfect correspondence between alpha and omega reported above reflects a substantial degree of item redundancy, in addition to tau-equivalence, and that several items within each dimension may capture highly overlapping content rather than fully distinct facets of the construct. This observation is discussed further in the limitations section and should inform future efforts to shorten the instrument.

Data Collection

The online survey was distributed to preschool teachers in the target city via a shared digital link in February 2026. Reach was achieved through institutional and professional network contacts, enabling access to teachers across different early childhood settings within the city. The survey platform allowed for anonymous completion, and no identifying information was collected beyond the demographic variables specified in the instrument. All participants provided informed consent prior to accessing the scale items.

Data Analysis

Several complementary analytical strategies were employed to address the study's research objectives, and all analyses were conducted using Jamovi statistical software (The Jamovi Project, 2024). Descriptive statistics, including means, medians (Mdn), and SDs, were computed for each of the nine scale dimensions to characterize the distribution of self-efficacy scores across the sample. The relationship between means and Mdns within each dimension was also examined as an initial indicator of distributional asymmetry.

To examine whether prior Kumon system experience and prior STEM teaching experience were associated with differences in subscale scores, Bayesian independent samples t-tests were conducted for each dimension separately. To investigate whether self-efficacy perceptions varied by teaching experience group or by educational level, Bayesian one-way analyses of variance (ANOVA) were performed. The Bayesian analytical framework was adopted in preference to conventional null hypothesis significance testing because it yields Bayes factors (BF10) that directly quantify the evidence in favor of the alternative model relative to the null. This approach enables a more epistemically appropriate interpretation of group comparisons, particularly when expected effects are small or the sample is moderate in size (König & van de Schoot, 2018; Kruschke, 2021). A BF10 value greater than 1.0 indicates support for the alternative model, while values below 1.0 indicate support for the null model; values exceeding 3.0 are conventionally interpreted as anecdotal-to-moderate evidence, and those above 10.0 as strong evidence (Jeffreys, 1961).

LPA was subsequently conducted to identify discrete subgroups of teachers characterized by meaningfully distinct patterns of self-efficacy across the nine dimensions. Unlike variable-centered mean comparisons, LPA is a person-centered approach that treats observed multivariate score profiles as arising from a mixture of latent subpopulations, making it possible to detect qualitatively different configurations of competency that group-level averages may conceal (Spurk et al., 2020). Solutions ranging from two to six latent classes were estimated and compared using multiple fit indices, including the Akaike information criterion (AIC), the Bayesian information criterion (BIC), the consistent AIC (CAIC), the corrected log-likelihood (CLC), the Kullback information criterion (KIC), the sample-size-adjusted BIC (SABIC), the integrated completed likelihood (ICL), and the approximate weight of evidence (AWE). Entropy values were additionally examined as indicators of classification precision, with values approaching 1.0 reflecting high certainty in class

Table 3. Descriptive statistics for scale dimensions

Dimension	N	M	Mdn	SD	Minimum	Maximum
KCDID	204	3.21	3.57	1.24	1.00	5.00
IAMC	204	3.17	3.57	1.24	1.00	5.00
SGS	204	3.30	3.71	1.20	1.00	5.00
SSDLC	204	3.35	3.83	1.22	1.00	5.00
MESC	204	3.36	3.83	1.19	1.00	5.00
FCCC	204	3.38	4.00	1.18	1.00	5.00
ELEMN	204	3.29	3.83	1.14	1.00	5.00
MBISSP	204	3.28	3.83	1.18	1.00	5.00
STEMIC	204	3.16	3.43	1.17	1.00	5.00

Table 4. Bayesian independent samples t-test by Kumon system experience

Dimension	M (SD): No experience (*n* = 120)	M (SD): Experience (*n* = 84)	BF10	Interpretation
KCDID	3.25 (1.16)	3.16 (1.36)	.174	Null model favored
IAMC	3.24 (1.15)	3.08 (1.38)	.225	Null model favored
SGS	3.32 (1.17)	3.27 (1.26)	.161	Null model favored
SSDLC	3.36 (1.17)	3.33 (1.29)	.158	Null model favored
MESC	3.39 (1.15)	3.32 (1.25)	.166	Null model favored
FCCC	3.40 (1.12)	3.36 (1.26)	.159	Null model favored
ELEMN	3.27 (1.07)	3.32 (1.23)	.161	Null model favored
MBISSP	3.27 (1.12)	3.28 (1.27)	.155	Null model favored
STEMIC	3.11 (1.11)	3.24 (1.25)	.206	Null model favored

assignment. The final class solution was selected based on converging evidence across these indices in conjunction with the theoretical interpretability of the resulting profiles.

FINDINGS

Descriptive Findings

Across all nine dimensions (**Table 3**), mean scores ranged narrowly between 3.16 (STEMIC) and 3.38 (FCCC), placing the group's collective self-efficacy at a moderate level on the five-point scale. What is immediately striking is not the variation between dimensions, which is modest, but the consistent gap between Ms and Mdns across **Table 3**. In every dimension, the Mdn exceeds the mean by a margin of 0.36 to 0.62 points, a pattern that signals negatively skewed distributions: the majority of participants reported higher self-efficacy, while a smaller number of very low scores pulled the mean downward. This asymmetry suggests that the "average" participant feels more capable than the mean alone implies.

The highest-scoring dimension, FCCC (M = 3.38, [Mdn] = 4.00), stands out both statistically and substantively. Family communication draws on interpersonal skills that teacher candidates develop broadly throughout their training, and indeed throughout daily life, making it perhaps the most transferable of all dimensions in the scale. At the opposite end, STEMIC (M = 3.16, Mdn = 3.43) and IAMC (M = 3.17, Mdn = 3.57) returned the lowest scores; both are technically demanding and relatively novel within standard teacher training curricula. STEM integration remains an emerging pedagogical domain, while diagnostic assessment in the context of individualized instruction demands a kind of precision that is rarely practiced during teacher education.

SDs were remarkably consistent across dimensions (1.14-1.24), and the full response range (1.00-5.00) was utilized in every case. This combination of high variability and moderate central tendency implies substantial heterogeneity within the sample: alongside participants who feel genuinely confident, a notable segment reported near-minimal self-efficacy. These inter-individual differences, rather than any single mean score, may be the most pedagogically consequential finding of the descriptive analysis.

Kumon System Experience

Perhaps one of the more counterintuitive results in this study, **Table 4** reveals that prior experience with the Kumon system does not translate into meaningfully higher self-efficacy scores across any of the nine competency dimensions. BF10 for all comparisons fell well below 1.0 (range: BF_{10} = 0.155-0.225), providing consistent support for the null model. In other words, the evidence provided moderate support for the conclusion that experienced and inexperienced groups are equivalent, rather than simply failing to detect a difference. This should be read as moderate rather than decisive evidence for equivalence.

The only dimension where experienced participants edged above the no-experience group was STEMIC (M = 3.24 vs. 3.11) and IAMC (M = 3.08 vs. 3.24, here reversed), yet neither approached the threshold of meaningful evidence. This null finding deserves genuine

Table 5. Bayesian independent samples t-test by STEM teaching experience

Dimension	M (SD): No (n = 82)	M (SD): Yes (n = 122)	BF10	Interpretation
KCDID	3.18 (1.05)	3.23 (1.36)	.162	Null model favored
IAMC	3.22 (1.10)	3.15 (1.34)	.167	Null model favored
SGS	3.32 (1.08)	3.28 (1.28)	.160	Null model favored
SSDLC	3.36 (1.08)	3.34 (1.31)	.156	Null model favored
MESC	3.31 (1.08)	3.40 (1.27)	.175	Null model favored
FCCC	3.33 (1.07)	3.42 (1.25)	.182	Null model favored
ELEMN	3.19 (1.06)	3.36 (1.19)	.251	Null model favored
MBISSP	3.25 (1.06)	3.29 (1.26)	.160	Null model favored
STEMIC	3.05 (1.05)	3.24 (1.24)	.281	Null model favored

Table 6. Bayesian ANOVA by teaching experience

Dimension	BF10	Model decision	Novice: M (SD)	Mid-career: M (SD)	Senior: M (SD)	Main pattern	Comment
KCDID	.407	Null model favored	3.19 (1.22)	3.04 (1.32)	3.59 (1.10)	Senior > novice > mid-career	Weak evidence for group differences
IAMC	.336	Null model favored	3.19 (1.24)	2.97 (1.30)	3.50 (1.12)	Senior > novice > mid-career	Weak evidence for group differences
SGS	.673	Null model favored	3.34 (1.14)	3.04 (1.29)	3.62 (1.17)	Senior > novice > mid-career	Difference pattern exists, but evidence is weak
SSDLC	-	Not reported	-	-	-	-	SSDLC result was not provided in the shared ANOVA output
MESC	.849	Null model favored	3.44 (1.15)	3.08 (1.24)	3.66 (1.17)	Senior > novice > mid-career	Evidence remains below 1
FCCC	2.19	Teaching experience model slightly favored	3.45 (1.12)	3.07 (1.24)	3.75 (1.12)	Senior > novice > mid-career	Anecdotal evidence for group differences
ELEMN	1.88	Teaching experience model slightly favored	3.41 (1.08)	2.96 (1.23)	3.51 (1.05)	Senior ≈ novice > mid-career	Anecdotal evidence for group differences
MBISSP	2.75	Teaching experience model slightly favored	3.44 (1.12)	2.92 (1.24)	3.44 (1.15)	Senior = novice > mid-career	Anecdotal evidence for group differences
STEMIC	.721	Null model favored	3.33 (1.13)	2.89 (1.23)	3.15 (1.13)	Novice > senior > mid-career	Weak evidence for group differences

reflection. It is tempting to assume that familiarity with a method automatically builds confidence in teaching it, yet the data suggest otherwise. Experience with Kumon as a learner or observer may not transfer to professional self-efficacy in delivering it as a teacher, particularly when that experience occurred outside a structured pedagogical training context. What participants have done is not the same as what they feel prepared to do.

STEM Teaching Experience

STEM teaching experience, like Kumon experience, does not produce statistically meaningful differences in self-efficacy across the scale dimensions. All BF10 remain below 1.0 (range: BF_{10} = 0.156-0.281), and the null model is favored throughout (**Table 5**). That said, two dimensions warrant closer attention even within this pattern of null results.

For STEMIC, participants who reported STEM teaching experience scored slightly higher (M = 3.24 vs. 3.05), and this comparison produced the highest BF10 in **Table 5** (BF_{10} = 0.281), still below the conventional threshold but less decisively null than the others. A similar, if smaller, pattern emerged for ELEMN (M = 3.36 vs. 3.19, BF_{10} = 0.251). These results hint at the possibility that domain-specific experience in STEM teaching may begin to shape confidence in related competencies, even if the effect remains too subtle for the current sample to detect reliably. Future research with larger samples or more fine-grained measures of STEM experience may clarify whether a meaningful relationship exists beneath the statistical noise.

Teaching Experience

Teaching experience tells a more interesting and nuanced story than either Kumon or STEM experience. Three dimensions (as shown in **Table 6**) crossed the BF_{10} = 1.0 threshold: MBISSP (BF_{10} = 2.75), FCCC (BF_{10} = 2.19), and ELEMN (BF_{10} = 1.88), providing at least anecdotal evidence that self-efficacy in these areas varies meaningfully with years of classroom experience. These

Table 7. Bayesian ANOVA by education level

Dimension	BF10	Model decision	College: M (SD)	Bachelor: M (SD)	Postgraduate: M (SD)	Main pattern	Comment
KCDID	.224	Null model favored	3.06 (1.31)	3.36 (1.09)	3.25 (1.53)	Bachelor highest	No convincing group effect
IAMC	.198	Null model favored	3.05 (1.35)	3.33 (1.08)	3.08 (1.41)	Bachelor highest	No convincing group effect
SGS	.111	Null model favored	3.21 (1.23)	3.40 (1.13)	3.26 (1.41)	Bachelor highest	Strong support for null model
SSDLC	.088	Null model favored	3.28 (1.27)	3.42 (1.12)	3.39 (1.46)	Bachelor slightly highest	Strong support for null model
MESC	.141	Null model favored	3.26 (1.24)	3.48 (1.08)	3.28 (1.47)	Bachelor highest	Strong support for null model
FCCC	.085	Null model favored	3.35 (1.26)	3.45 (1.03)	3.25 (1.44)	Bachelor highest	Strong support for null model
ELEMN	.102	Null model favored	3.30 (1.22)	3.33 (1.03)	3.03 (1.25)	Bachelor slightly highest	Strong support for null model
MBISSP	.579	Null model favored	3.24 (1.22)	3.42 (1.09)	2.74 (1.29)	Bachelor highest	Null model still favored
STEMIC	.277	Null model favored	3.15 (1.23)	3.27 (1.05)	2.70 (1.35)	Bachelor highest	No convincing group effect

are domains where time-in-practice plausibly matters: mastery-based instruction requires calibrated judgment developed through repeated teaching cycles, family communication deepens with actual parent interactions, and early content knowledge consolidates through sustained classroom use.

The pattern of group differences across all dimensions with available data is strikingly consistent: senior teachers reported the highest self-efficacy, mid-career teachers the lowest, and novice teachers fell in between. This non-linear, U-shaped trajectory challenges the straightforward assumption that experience accumulates steadily. Mid-career teachers, typically those who have moved beyond the novelty and structured support of early teaching but have not yet reached the consolidation of experienced practice, appear to experience a trough in self-efficacy. The phenomenon echoes the broader literature on mid-career professional development, where plateauing or uncertainty can temporarily suppress confidence.

STEMIC offers a notable exception to this pattern: novice teachers reported the highest self-efficacy (M = 3.33), followed by senior (M = 3.15) and mid-career (M = 2.89) teachers, a pattern consistent with the literature on STEM and innovation readiness, where enthusiasm and openness among beginning teachers may temporarily outpace the accumulated caution or habitual practices of more experienced colleagues. This finding, while based on weak evidence (BF_{10} = 0.721), is conceptually meaningful and merits follow-up.

Educational Level

Across all nine dimensions (as shown in **Table 7**), educational level, whether college diploma, bachelor's degree, or postgraduate qualification, produced no convincing group differences. Most BF10 are not only below 1.0 but substantially so, with FCCC (BF_{10} = 0.085), SSDLC (BF_{10} = 0.088), and ELEMN (BF_{10} = 0.102) providing strong support for the null model. The data are, in Bayesian terms, actively informative: higher educational credentials do not appear to distinguish teacher candidates' Kumon-specific self-efficacy profiles.

One pattern that recurs quietly across **Table 7** is the tendency for bachelor's degree holders to score slightly higher than their postgraduate counterparts on several dimensions, most visibly in MBISSP (bachelor M = 3.42 vs. postgraduate M = 2.74) and STEMIC (3.27 vs. 2.70). Whether this reflects the composition of postgraduate programs in the sample, a tendency for more self-critical reflection among higher-credentialed participants, or simply sampling variance remains unclear. What **Table 7** does confirm is that credentialing, at least as measured here, is not a reliable proxy for domain-specific self-efficacy in early childhood Kumon-oriented teaching, a finding with practical implications for selection and professional development program design.

Latent Profile Analysis

The model selection process examined multiple latent profile solutions (**Table 8**), and the final three-class solution strikes a well-justified balance between statistical fit and interpretive parsimony. Across all candidate models, entropy values were consistently high (0.824-0.987), indicating that individuals were assigned to latent classes with strong probabilistic certainty, which is a prerequisite for meaningful profile interpretation. The three-class solution retained a high entropy value alongside competitive information criteria, and its profiles proved theoretically coherent in a way that finer-grained solutions rarely sustain.

Table 8. Model fit indices for LPA

Model	Classes	LogLik	AIC	AWE	BIC	CAIC	CLC	KIC	SABIC	ICL	Entropy
1	2	-2081	4217	4541	4310	4338	4163	4248	4221	-4311	0.987
1	3	-1908	3891	4332	4017	4055	3817	3932	3897	-4031	0.940
1	4	-1789	3674	4230	3833	3881	3580	3725	3681	-3842	0.963
1	5	-1718	3552	4225	3744	3802	3438	3613	3561	-3753	0.967
1	6	-1630	3396	4186	3622	3690	3262	3467	3407	-3627	0.981
2	2	-2061	4197	4626	4320	4357	4125	4237	4203	-4321	0.986
2	3	-1779	3670	4320	3856	3912	3560	3729	3679	-3864	0.959
3	2	-1359	2845	3588	3058	3122	2719	2912	2855	-3060	0.975
3	3	-1310	2767	3626	3013	3087	2621	2844	2778	-3017	0.976
3	4	-1276	2720	3696	2999	3083	2554	2807	2733	-3003	0.978
3	5	-1253	2693	3785	3005	3099	2507	2790	2707	-3010	0.982
3	6	-1237	2682	3890	3027	3131	2475	2789	2697	-3096	0.824
6	2	-1165	2548	3814	2910	3019	2332	2660	2564	-2915	0.935
6	3	-955	2238	4144	2782	2946	1912	2405	2262	-2786	0.968

Table 9. Class sizes

Class	Count	Percentage of total	Suggested label
1	84	41.2	High competency profile
2	37	18.1	Low competency profile
3	83	40.7	Moderate competency profile

Table 10. Class-specific means across dimensions

Dimension	Class 1: M (SD)	Class 2: M (SD)	Class 3: M (SD)
KCDID	4.11 (0.53)	1.56 (0.47)	3.03 (1.16)
IAMC	4.08 (0.48)	1.55 (0.44)	2.99 (1.21)
SGS	4.08 (0.50)	1.45 (0.39)	3.32 (1.05)
SSDLC	4.11 (0.50)	1.60 (0.43)	3.36 (1.17)
MESC	4.12 (0.48)	1.55 (0.39)	3.40 (1.07)
FCCC	4.12 (0.49)	1.58 (0.43)	3.45 (1.05)
ELEMN	4.03 (0.49)	1.57 (0.43)	3.31 (1.00)
MBISSP	4.00 (0.50)	1.56 (0.41)	3.31 (1.12)
STEMIC	3.96 (0.51)	1.56 (0.44)	3.06 (1.10)

The three emergent profiles (**Table 9**) differ not merely in degree but in kind. Class 1 (high competency profile, n = 84, 41.2%) reported means between 3.96 and 4.12 with small SDs (approximately 0.49-0.53), reflecting both high self-efficacy and remarkable internal consistency; these teachers are confident across the board, with little within-class variation. Class 2 (low competency profile, n = 37, 18.1%) shows the opposite: means clustered between 1.45 and 1.60 represent near-minimal self-efficacy, with similarly tight dispersions (SD approximately 0.39-0.47). This is not a group marked by uncertainty or ambivalence; the pattern is consistent and decisive. Class 3 (moderate competency profile, n = 83, 40.7%) sits between these poles with means ranging from 2.99 to 3.45, but with substantially wider SDs (approximately 1.00-1.21), indicating considerably more heterogeneity within this profile.

Across all three classes, STEMIC consistently emerges as the weakest dimension (**Table 10**). In class 1, STEMIC (M = 3.96) sits below every other dimension; in class 3, it is again the lowest (M = 3.06). Similarly, IAMC and KCDID tend to rank lower within profiles than relational competencies such as MESC and FCCC, a pattern that echoes the descriptive findings and reinforces the conclusion that assessment and child development knowledge represent structurally more demanding domains for teachers, regardless of their overall competency level.

The distributional split itself is instructive: roughly four in ten participants fall into the high competency class, four in ten into the moderate class, and just under two in ten into the low class. The relative symmetry of the high and moderate groups, alongside the smaller but distinct low-competency cluster, suggests a field in which genuine polarization exists. A meaningful minority of participants exhibit a systematically low sense of capability across all Kumon-related competencies, a finding that invites programmatic attention.

Distribution of Demographic Variables Across Classes

The demographic profiles of each class reveal subtle but worth-noting patterns. Regarding educational level (**Table 11**), the three groups are broadly comparable, though postgraduate participants appear somewhat

Table 11. Distribution of educational level across classes

Variables		Class 1	Class 2	Class 3	Total
Educational level	College degree	40	18	37	95
	Bachelor's degree	37	13	40	90
	Postgraduate degree	7	6	6	19
Teaching experience	Novice	49	12	43	104
	Mid-career	22	19	23	64
	Senior	13	6	17	36
Kumon experience	No	52	17	51	120
	Experience	32	20	32	84
STEM teaching experience	No	32	11	39	82
	Yes	52	26	44	122

concentrated in the low-competency class relative to their share of the total sample (6 of 19, or approximately 32%), compared to 7 in the high class. This is not a dramatic imbalance, but it reinforces the earlier finding that formal educational credentials do not necessarily translate into higher self-efficacy in this context.

Teaching experience produces perhaps the clearest demographic signal across the class structure. Mid-career teachers, who make up 31% of the total sample, account for 51% of the low-competency class (19 of 37), a disproportionate concentration that gives quantitative shape to the mid-career dip observed in **Table 6**.

The high-competency class, by contrast, is predominantly composed of novice teachers (49 of 84, or 58%), suggesting that early-career enthusiasm and openness may sustain self-efficacy even before practical experience has fully consolidated.

Kumon experience is distributed surprisingly evenly across classes. Among participants with Kumon experience, 38% fall in the high-competency class, 24% in the low class, and 38% in the moderate class, a distribution that corroborates the null finding from **Table 4**. Experience with the Kumon method is not a protective factor against low self-efficacy, nor a reliable pathway into the high-competency profile.

STEM teaching experience shows a slight tendency toward the high and moderate classes: among STEM-experienced participants, 43% appear in class 1 and 36% in class 3, compared to 30% of non-STEM-experienced participants in class 1. While this difference is modest and must be interpreted with caution given the overall null result from **Table 5**, it is directionally consistent with the slightly elevated BF10 observed for STEMIC and ELEMN in the between-group comparisons.

Together, these demographic distributions underscore a central message: the competency profiles that emerge from LPA are not cleanly explained by any single background variable, pointing instead to a multifactorial configuration of readiness that transcends credential, experience, or prior exposure.

DISCUSSION

In this study, an instrument was developed to measure teachers' self-efficacy perceptions in Kumon method-based preschool teaching across nine dimensions, and the resulting data were analyzed through descriptive statistics, Bayesian comparisons, and LPA. The findings reveal patterns worth discussing for both the psychometric structure of the scale and the nature of teacher self-efficacy.

In all nine dimensions, mean scores fell between 3.16 and 3.38, within a moderate self-efficacy band on the five-point scale. This narrow range might suggest little differentiation between dimensions; however, the Mdn values were consistently and substantially above the means (by 0.36-0.62 points), indicating negatively skewed distributions. Most teachers reported relatively high self-efficacy while a small subgroup of low scorers pulled the mean down, meaning that the arithmetic mean alone can misrepresent how the "average" teacher perceives their own competence.

The relative ranking of the dimensions also deserves comment. FCCC received the highest scores, while STEMIC and IAMC received the lowest. This pattern plausibly reflects differences in the nature of these competencies rather than random variation: family communication draws on interpersonal skills teachers develop continuously through their own lives, whereas STEM integration and diagnostic assessment are more technically demanding domains not yet systematically embedded in teacher education. This interpretation carries an important caveat, however.

Each of the nine dimensions was validated as an independent single-factor congeneric model rather than as part of an integrated nine-factor confirmatory model, so the present data support treating each dimension as internally coherent without establishing its discriminant validity relative to the other eight. The between-dimension comparisons that follow should therefore be read as differences in reported content rather than as confirmed differences between fully validated, orthogonal constructs.

One of the more unexpected findings was that prior experience with the Kumon system made no significant difference on any competence dimension (BF_{10} = 0.155-0.225 across all nine), which seems counterintuitive given that familiarity with a method might be expected to build confidence in applying it. A likely explanation lies in the nature of that experience: encountering the Kumon system as a student or observer may not transfer to a teacher's self-efficacy for implementing it, since direct mastery experiences are a stronger source of self-efficacy than indirect ones (Bandura, 1997). Participants' prior Kumon exposure probably occurred at an informal, acquaintance level rather than through structured pedagogical training, a distinction between familiarity and readiness to teach that teacher education programs should take seriously.

STEM teaching experience showed a similar overall pattern: the null model was supported across all nine dimensions (BF_{10} = 0.156-0.281), though two dimensions, STEMIC (*M* = 3.24 vs. 3.05) and ELEMN (*M* = 3.36 vs. 3.19), showed comparatively higher BF10. While still below conventional thresholds, this provides a weak, directional signal that domain-specific experience may begin to shape confidence in related competencies, consistent with cross-cultural evidence that STEM confidence develops largely independently of general teaching experience (Sukri & Mahmud, 2022; Yang et al., 2023).

Teaching experience produced a more complex picture. BF10 exceeded 1.0 for three dimensions, Mastery-Based Instruction (BF_{10} = 2.75), Family Communication (BF_{10} = 2.19), and ELEMN (BF_{10} = 1.88), each an area where judgment plausibly sharpens through repeated practice, real parental interaction, and sustained classroom use, respectively.

The most striking pattern, however, was non-linear: across dimensions with available data, senior teachers reported the highest self-efficacy, mid-career teachers the lowest, and novice teachers fell in between. This U-shaped curve, consistent with non-linear experience effects reported elsewhere (Infurna et al., 2018; Ye et al., 2024), suggests that mid-career teachers occupy a transitional period, having left the structured support of early practice without yet reaching the consolidated confidence of experienced colleagues.

STEMIC was a notable exception to this pattern: novice teachers reported the highest self-efficacy (*M* = 3.33), followed by senior (*M* = 3.15) and mid-career (*M* = 2.89) teachers, consistent with the broader literature on STEM and innovation readiness, where the enthusiasm of beginning teachers can temporarily outpace the more cautious habits of experienced colleagues.

Educational level strongly supported the null model across all nine dimensions, with especially low BF10 for FCCC (BF_{10} = 0.085), SSDLC (BF_{10} = 0.088), and ELEMN (BF_{10} = 0.102). This replicates null findings for education level reported elsewhere for family-partnership and STEM self-efficacy (Moen & Sheridan, 2020; Sukri & Mahmud, 2022) and suggests that formal credentials capture exposure to training rather than the belief-based components self-efficacy scales are designed to measure.

A subtler pattern also emerged: bachelor's-degree holders tended to score higher than postgraduates on some dimensions, most visibly MBISSP (*M* = 3.42 vs. 2.74) and STEMIC (*M* = 3.27 vs. 2.70). Rather than advanced education undermining confidence, a more likely explanation is that postgraduate teachers have developed more calibrated, self-critical assessment frameworks and are more aware of what they do not know, a pattern consistent with broader research on the relationship between expertise and self-awareness of knowledge limits.

Moving beyond variable-centered comparisons, LPA identified three qualitatively distinct competence profiles: a high efficacy profile with uniformly high, low-variance scores (*M* = 3.96-4.12); a low efficacy profile with uniformly low scores (*M* = 1.45-1.60) reflecting systematic rather than ambivalent low confidence; and a moderate profile occupying the middle ground but with substantially greater heterogeneity (*M* = 2.99-3.45, *SD* ≈ 1.00-1.21). STEMIC was the lowest-scoring dimension within every profile, and IAMC and KCDID also ranked below the relational competencies (MESC, FCCC) throughout, confirming that assessment and child development knowledge are structurally demanding domains regardless of a teacher's overall competence level.

The demographic distribution across profiles is informative in its own right. Mid-career teachers made up 31% of the sample but 51% of the low efficacy profile (19 of 37), giving quantitative shape to the mid-career trough identified in the Bayesian ANOVA, while the high efficacy profile was predominantly composed of novice teachers (49 of 84, 58%). The even distribution of Kumon experience across profiles corroborates the null finding in **Table 4**: prior Kumon exposure is neither protective against low self-efficacy nor a reliable route to a high-efficacy profile.

This person-centered pattern is consistent with Kaļķe et al.'s (2022) multidimensional view of teacher competence and with Spurk et al.'s (2020) argument that such approaches shift the research question from which group scores lower on average to who needs targeted support.

Some limitations need to be considered when evaluating these findings. The sample was drawn from a single city in southern Kazakhstan, which limits generalizability to other cultural and educational contexts, and the cross-sectional design cannot capture change in self-efficacy over time. The scale is self-report based, and the relationship between self-efficacy perceptions and observed classroom behavior was not directly tested. Zou (2022) documented a consistent gap between teachers' espoused beliefs and observed behavior, and this belief-practice gap may apply here as well. A further limitation concerns the CFA strategy: because the ratio of participants (n = 204) to the full item pool (58 items) did not support estimation of an integrated nine-factor CFA model, each subscale was tested separately as an independent single-factor congeneric model. The present analysis therefore supports the internal factorial coherence of each subscale in isolation but does not constitute a confirmatory test of the full nine-dimensional structure, and claims about the overall nine-dimensional architecture of the instrument should be read as provisional pending replication with a larger sample.

The absence of a formal CVR or CVI during the expert review process is a further limitation of the scale development procedure rather than a stylistic choice, and future revisions should incorporate a quantitative CVI. The reliability values were extremely high across all dimensions (α = 0.959-0.981), and a direct inspection of item-level correlations confirmed uniformly high inter-item correlations within each subscale as well (mean r = .80-.89), together indicating probable redundancy among items rather than exceptional measurement precision alone. Future studies should consider narrowing the item pool and developing a shorter form. Finally, the relatively small number of participants (n = 37) in the low efficacy profile requires cautious interpretation of the inferences regarding this profile.

CONCLUSION

General Evaluation

This study aimed to develop a psychometrically robust instrument to measure teachers' self-efficacy perceptions across nine competency dimensions in Kumon method-based preschool teaching, and to examine teacher competency profiles using this instrument. Conducted with 204 preschool teachers in southern Kazakhstan, the study found moderate self-efficacy overall, with relatively high scores in interpersonal dimensions such as family communication and relatively low scores in technically demanding dimensions such as STEM integration and individual assessment. Neither Kumon nor STEM teaching experience differentiated self-efficacy, teaching experience followed a non-linear, U-shaped pattern in which mid-career teachers scored lowest, education level showed no discriminating effect, and LPA identified three qualitatively distinct competence profiles, with mid-career teachers disproportionately represented in the low-competence group.

Practical Implications for Professional Development

The findings translate into specific, actionable recommendations rather than a general call for more professional development, centered on four patterns: the low scores on STEMIC and IAMC competencies, the mid-career dip in self-efficacy, and the distinct low competency profile (18.1% of the sample, n = 37).

Because STEMIC was the lowest-scoring dimension in nearly every comparison, including within each latent profile, general STEM-awareness training is unlikely to be sufficient. In-service training should instead offer a dedicated module on designing STEM activities within the Kumon small-step mastery framework, delivered through short, repeatable workshop cycles paired with in-classroom coaching.

IAMC, the second-lowest dimension, concerns concrete, learnable skills, placement-test administration, progress documentation, and criterion-based advancement decisions. Teacher preparation and induction programs should include structured, supervised practice with real placement and progress-monitoring cases, ideally mentored by an experienced Kumon teacher during a teacher's first year.

The U-shaped relationship between experience and self-efficacy calls for a shift in timing: mid-career teachers, who accounted for 51% of the low competency profile (19 of 37) despite representing only 31% of the sample, need renewal-focused professional development, such as updated Kumon-STEM techniques and peer observation, as much as induction-year teachers do.

Teachers in the low competency profile showed uniformly low self-efficacy ($M \approx 1.5$) across all nine dimensions rather than an isolated weakness, suggesting that a comprehensive, multi-domain program would serve them better than single-topic workshops, though the profile's small size (n = 37) warrants local replication before large-scale resource allocation.

Finally, because item-level correlations indicate substantial redundancy within each dimension, dimension scores rather than individual items should guide any professional development needs assessment until a shorter form is validated.

Suggestions for Future Research

Several directions for future research follow from the findings and limitations of this study. Cross-cultural validation in contexts where the Kumon method is widespread, such as Central Asian, Southeast Asian, or Latin American settings, would test measurement invariance and the generalizability of the present factor structure. Because the current design is cross-sectional, longitudinal or panel studies tracking teachers from training through the early and mid-career years would help clarify whether the mid-career trough is a temporary period or a stable structural feature.

Directly testing the relationship between self-reported self-efficacy and observed classroom behavior would strengthen the scale's predictive validity, particularly given the belief-practice gap documented by Zou (2022); mixed-method designs could help identify dimensions in which teachers report high self-efficacy but struggle in practice. Expanding the predictors of latent profile membership beyond demographic indicators, to include motivational orientation, teaching beliefs, and professional satisfaction, would also support more refined, targeted intervention programs for teachers in the low-competence profile.

Given that STEMIC consistently scored lowest across all analyses, experimental or quasi-experimental intervention studies, particularly those testing STEM activities integrated within the Kumon framework, would contribute at both theoretical and practical levels. Finally, because of the uniformly high reliability coefficients (α = 0.959-0.981) and item-level correlations reported before point to possible redundancy, future work should consider item-response-theory or discriminant item analysis to develop a shorter, less redundant form of the instrument.

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APPENDIX A

Table A1. Scale

No	Item
Dimension 1: Knowledge of child development and individual differences	
1	I can identify the cognitive developmental stages (e.g., preoperational stage) of preschool-aged children.
2	I can plan instruction by taking into account each child's individual learning pace.
3	I can identify the gap between a child's actual developmental level and potential developmental level (ZPD).
4	I can assess children's social-emotional development indicators through observation.
5	I can design activities by considering children's fine and gross motor development levels.
6	I can determine the "just-right level" for each child and select an appropriate starting point.
7	I can plan instruction by taking into account each child's individual learning style.
Dimension 2: Individual assessment and monitoring competency	
8	I can use appropriate diagnostic tools (e.g., placement tests) to determine a child's current academic level.
9	I can systematically record and analyze children's worksheet performance (accuracy and speed).
10	I can analyze children's errors to identify conceptual areas in which they experience difficulty.
11	I can create an individualized study plan (study projection) for each child.
12	I can regularly update the individualized study plan (study projection) for each child.
13	I can continuously monitor the child's progress using a formative assessment approach.
14	I can decide, based on assessment results, whether a child is ready to advance to the next level.
Dimension 3: Scaffolding and guidance skills	
15	I can provide guiding hints rather than giving the answer directly when a child encounters a problem.
16	I can transition between high-support and low-support strategies according to the child's developmental level.
17	I can gradually withdraw my support (fading) when I notice the child is able to work independently.
18	I can support the child's thinking process through open-ended and guiding questions.
19	I can encourage the child to find solutions independently by examining the examples on the worksheet.
20	I can provide contingent and flexible guidance responsive to each child's needs.
21	I can introduce a new concept to the child by modeling (demonstrating) the solution process.
Dimension 4: Supporting self-directed learning competency	
22	I can create appropriate environments and routines to help children develop daily study habits.
23	I can implement strategies to gradually increase the child's attention span and concentration capacity.
24	I can help children recognize their own errors by providing opportunities for self-assessment.
25	I can establish appropriate conditions for the child to complete worksheets independently.
26	I can use approaches that foster self-discipline and a sense of responsibility in children.
27	I can encourage the child to use the cues in worksheets to manage their own learning process.
Dimension 5: Motivation and emotional support competency	
28	I can support child's self-confidence by acknowledging each achievement (correct answers, level completion, etc.).
29	I can demonstrate an encouraging approach rather than a negative attitude when a child struggles or makes errors.
30	I can help children manage the frustration and distress they experience during the learning process.
31	I can develop strategies to maintain the child's interest and motivation during repetitive practice tasks.
32	I can provide feedback that strengthens the child's academic self-esteem.
33	I can increase the child's desire to learn by creating a warm, safe, and supportive learning environment.
Dimension 6: Family communication and collaboration competency	
34	I can regularly provide parents with clear and comprehensible information about child's progress and study plan.
35	I can effectively guide families on how to conduct home study activities.
36	I can build a trust-based partnership with families to collaboratively support the child's learning process.
37	I can listen empathetically to families' concerns and expectations and suggest appropriate solutions.
38	I can develop collaboration with families to ensure learning continuity between home and school/center.
39	I can support motivation at home by sharing the child's progress and achievements with the family.
Dimension 7: Early literacy and early mathematics knowledge	
40	I have knowledge of phonemic awareness and can plan activities to develop it.
41	I can teach letter–sound relationships (phonics) at an appropriate level for preschool-aged children.
42	I can gradually develop children's understanding of number concepts, number sequences, and numeral writing skills.
43	I understand the incremental difficulty structure of Kumon worksheets (levels starting from 6A).
44	I am familiar with instructional methods for pre-reading skills (word recognition, repetition, matching).
45	I can translate current pedagogical knowledge in early mathematics and early literacy into practice.

Table A1 (Continued).

No	Item
Dimension 8: Mastery-based instruction and small-step progression	
46	I can apply principle that a child should not advance to the next level without achieving mastery in the current topic.
47	I can break learning content into small, manageable steps to ensure the child experiences a sense of accomplishment.
48	I can manage the progression process while respecting each child's individual pace.
49	I can conduct an objective assessment by establishing mastery criteria (accuracy rate, completion time).
50	I can plan appropriate corrective activities to review the relevant topic when a child struggles at a level.
51	I understand the importance of repetition and practice in the learning process and can implement them effectively.
Dimension 9: STEM integration competency	
52	I can apply Kumon's individualized pacing principle in STEM exploration activities.
53	I can connect the concepts in mathematics worksheets with science and engineering activities.
54	I can integrate inquiry-based learning with Kumon's small-step approach in STEM activities.
55	I can design interdisciplinary STEM activities for preschool-aged children.
56	I can develop structured materials to support children's self-directed learning skills in STEM activities.
57	I can progressively develop children's STEM process skills (observing, classifying, predicting, experimenting).
58	I can track progress by documenting children's scientific thinking processes in STEM implementations.

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